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(54) Title: LOSSLESS REGION OF INTEREST CODING

(57) Abstract

In a method and a device for transmission of S+P transform coded digitized images a mask is calculated by means of which a region of interest (ROI) can be transmitted lossless whereby the ROI can be transmitted and received lossless and still maintaining a good compression ratio for the image as a whole. This is possible since no or very few bits can be used for the remaining part of the image. The calculated mask can also be used for transmitting the coefficients needed for a lossless region of interest during any stage of the transmission.

LOSSLESS REGION OF INTEREST CODING

TECHNICAL FIELD
The present invention relates to a method and a device
for lossless coding of a region of interest (ROI) in
transmission of a still image. The method and the device
are particularly well suited for the S+P transform.

BACKGROUND OF THE INVENTION AND PRIOR ART
In transmission of digitized still images from a
transmitter to a receiver, the image is usually coded in
order to reduce the amount of bits required for
transmitting the image.

The reason for reducing the amount of bits is usually
that the capacity of the channel used is limited. A
digitized image, however, consists of a very large number
of bits. When transmitting such an image, consisting of a
very large number of bits, over a channel, which has a
limited bandwidth, transmission times for most
applications become unacceptably long, if every bit of
the image has to be transmitted.

Therefore, much research efforts in recent years have
concerned coding methods and techniques for digitized
images, aiming at reducing the number of bits necessary
to transmit.

These methods can be divided into two groups:

Lossless methods, i.e. methods exploiting the redundancy
in the image in such a manner that the image can be
reconstructed by the receiver without any loss of
information.

Lossy methods, i.e. methods exploiting the fact that all
bits are not equally important to the receiver, hence the
received image is not identical to the original, but
looks, e.g. for the human eye, sufficiently alike the

original image.

Furthermore, in some applications a part of a transmitted
image may be more interesting than the rest of the image
and a better visual quality of this part of the image is
therefore desired. Such a part is usually termed region
of interest (ROI). An application in which this can be
useful is for example medical databases. In some cases it
is also desired or required that the region of interest
is transmitted lossless, while the quality of the rest of
the image is of less importance.

One method, which can be used, for coding of still images
is the wavelet based S+P transform. The S+P transform is
completely reversible and can be performed directly
without memory expansion. The S+P transform is described
in A. Said and W. A. Pearlman, `Reversible image
compression via multiresolution representation and
predictive coding', in Proc. SPIE Conf. Visual
Communications and Image Processing '93, Cambridge, MA,
Nov. 1993, Proc. SPIE 2094, pp. 664-674, which is
incorporated herein by reference.

It consists of the S transform, see V.K Heer and H-E.
Reinfelder, `A comparison of reversible methods for data
compression', Proc. SPIE, vol. 1233 Med. Imag. IV, pp
354-365, 1990., which also is incorporated herein by
reference and which is a pyramid sub band decomposition,
and of a prediction used to take out the remaining
redundancies from the high frequency sub bands. The
forward transformation is done by applying a subband
decomposition several times. The inverse is found by
applying the corresponding compositions in reverse order.

In J. Ström, P. C. Cosman, `Medical image compression
with lossless regions of interest', Signal Processing 59,
Nr 2, Jun. (1997) 155-171 it is described how a lossless
region of interest can be calculated for the S transform.

However, when trying to apply such a technique to the
wavelet based S+P transform, i.e. lossless transmission
of the region of interest and a lossy transmission of the
rest of the image, no straightforward technique can be
used.

Thus, today there exist no way for lossless region of
interest coding of an S+P transformed image. This is due
to the fact that it is not easy to select the information
in the S+P transformation coded original image which
should be transmitted in order to obtain a perfect,
lossless reconstruction of the region of interest,
without having to transmit the entire image lossless.

SUMMARY
It is an object of the present invention to solve the
problem of how to select the data in an S+P transformed
image in order to achieve a lossless region of interest
in a receiver.

This object is obtained by means of calculating a mask
for the region of interest as will be described below.

Thus, in order to achieve a perfectly reconstructed
region of interest, while maintaining a fair amount of
compression, bits need to be saved by sending less
information about the background or the part of the image
which is not interesting, or at least wait with that
information until a later stage in the transmission.

To do this, a lossless mask is calculated. The mask is a
bit plane indicating which wavelet coefficients have to
be exactly transmitted if the receiver should be able to
reconstruct the desired region perfectly. In the case
that an ROI in the image is chosen to be lossless, the A-
predictor used in the S+P transform referred to above
should be used.

This is because when the A-predictor is used no

prediction of high frequencies is performed with the help
of high frequencies. If this was the case, like in the C-
predictor case, see the reference above, a possible error
might propagate all the way to the edge of the image, and
also inside the ROI, making it unfeasible to provide a
lossless ROI.

The mask is calculated following the same steps as the
forward S+P transform, i.e. tracing the inverse transform
backwards. To start out with, the mask is a binary map of
the ROI, so that it is 1 inside the ROI and 0 outside. In
each step it is then updated line by line and then column
by column. In each step the mask is updated so that it
will indicate which coefficients are needed exactly at
this step, for the inverse S+P to reproduce the
coefficients of the previous mask exactly.

The last step of the inverse S+P is a composition of two
sub bands. To trace this step backwards, the coefficients
in the two sub bands that are needed exactly are found.
The second last step is a composition of four sub bands
into two. To trace this step backwards, the coefficients
in the four sub bands that are needed to give a perfect
reconstruction of the coefficients included in the mask
for two sub bands are found.

All steps are then traced backwards to give a mask that
implicates the following:

If the coefficients corresponding to the mask are
transmitted and received exactly, and the inverse S+P
(with the A-predictor) calculated on them, the desired
ROI will be reconstructed perfectly.

To trace a step backwards on a separate line, where $X_m(n)$
is the mask before the step inversion, $L_m(n)$ and $H_m(n)$ are
the masks for the low and high frequency sub band
afterwards, the following steps are carried out:

For the S+P with the A predictor:

For all n in $\left[1,\frac{N}{2}\right]$ do:

$$Hm(n) = 1 \quad \text{If} \quad \{Xm(2n) = 1\}OR\{Xm(2n+1) = 1\} \quad , \quad 0 \text{ otherwise}$$

$$Lm(n) = 1 \quad \text{If} \quad \{Xm(2n-2) = 1\}OR\{Xm(2n-1) = 1\}OR$$

$$\{Xm(2n) = 1\}OR\{Xm(2n+1) = 1\}OR$$

$$\{Xm(2n+2) = 1\}OR\{Xm(2n+3) = 1\}, \quad 0 \text{ otherwise}$$

Thus, the binary mask for the low frequency sub band and the high frequency sub band, respectively is set to a binary one, i.e. the corresponding coefficient is to be transmitted in order to obtain a lossless region of interest, if the above conditions are fulfilled.

For synchronisation, the same mask is found both in the encoder and the decoder. After a certain stage, skipping can be switched on and background list entries detected. These are the ones corresponding to sets containing no coefficients that are indicated for exact transmission by the lossless mask.
The background list entries can then be skipped totally, put in a wait list for later improvement or given a lower priority in some kind of interleaving scheme.

Furthermore, the shape of the ROI does not have to be defined before the transmission and can therefore be specified either by the transmitter or the receiver at any stage of the transmission.

The ROI can also be formed by two or more parts, which are not in contact with each other. The technique is then applied in the same manner.

BRIEF DESCRIPTION OF THE DRAWINGS
The present invention will now be described in more detail by way of a non-limiting examples and with reference to the accompanying drawings, in which:
- Fig. 1 is a general transmission system employing the

S+P transform.

- Figs. 2a and 2b are flow charts illustrating different steps when coding the region of interest for an S+P transformed still image.

- Figs. 3a - 3e are illustrations of the calculation of a lossless mask for different sub band stages.

DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1 a general transmission system employing the S+P transform is shown. The system comprises an S+P coder block 101, which is connected to an ROI coding block 103. The S+P block 101 encodes an input image according to the S+P transform referred to above. The coder 101 can receive information on a particular part of the image, which is interesting, i.e. the region of interest (ROI) from a receiver or decoder 107 over a channel 105.

The information is then forwarded to the ROI block 103 which calculates the coefficients of the S+P transformed image which should be transmitted in order to provide the decoder 107 with a lossless region of interest. The decoder 107 is connected to a block 109 wherein corresponding ROI decoding can be performed.

In Figs. 2a and 2b flow charts illustrating the different steps, which are carried out in the ROI block 103 in Fig. 1 when calculating the region of interest for an S+P transformed still image, are shown.

Thus, in the ROI block 103 in fig. 1, the following coding is executed. First the coding process is started in a block 201. Then, in a block 203 the calculation of an ROI mask is initiated. Thereupon, in a block 205 the horizontal sub band length is set equal to the horizontal image size and the vertical sub band length is set equal to the vertical image size.

Next, in a block 207 the first sub band level, corresponding to the first level of the transform, that

is the highest frequency octave of bands, is looked at,
and the procedure proceeds to a block 209 in which the
first horizontal line is looked at. Thereupon, in a block
211 the horizontal line is updated. The updating
procedure is described in more detail below in
conjunction with Fig. 2b.

Next, in a block 213 the horizontal line number is
incremented by one and then in a block 215 it is checked
if the horizontal line number is smaller than or equal to
the vertical sub band length. If this is the case the
process returns to the block 211 and else it proceeds to
a block 217.

In the block 217, the first vertical line number is
looked at. Next in a block 219, the vertical line number
is updated according to the procedure described below in
conjunction with Fig. 2b.

Thereupon, in a block 221 the vertical line number is
incremented by one, and next, in a block 223, it is
checked if the vertical line number is smaller than or
equal to the vertical sub band length. If this is the
case the process returns to the block 219 and else it
proceeds to a block 225.

In the block 225 the horizontal sub band length and the
vertical sub band length are both divided by two.
Thereupon in a block 227 it is checked if this was the
last level. If this is the case the process proceeds to a
block 229 in which the process stops and else it returns
to the block 209.

In Fig. 2b the procedure executed in the blocks 211 and
219 in Fig. 2a is described more in detail. Thus, the
procedure starts in a block 251. Then in a block 253 a
parameter n corresponding to the order number in the line
to be updated is set to zero. Next in a block 255 it is
evaluated if the coefficient number n in the line to be

updated is required for obtaining a lossless ROI because
it is required for the prediction of the coefficients
(2n-2), (2n-1), (2n), (2n+1), (2n+2) and (2n+3).

Thus, if the mask before the step inversion is a binary
one for (2n-2), (2n-1), (2n), (2n+1), (2n+2) or (2n+3),
the procedure proceeds to a block 257 and else it
proceeds to a block 259. In the block 257, the
coefficient n in the line which is currently updated is
set to a binary one (ON), i.e. the coefficient is needed
for obtaining a lossless ROI, and in the block 259 the
coefficient n in the line which is currently updated is
set to a binary zero (OFF). Next the procedure proceeds
from the blocks 257 and 259, respectively to a block 261.

In the block 261 it is checked if the coefficient number
(n + m/2), where m is the length of the line which is
currently updated is needed for obtaining a lossless ROI.
If the evaluation in the block 261 results in a yes the
procedure proceeds to a block 263 and else it proceeds to
a block 265.

In the block 263 the coefficient number (n + m/2) in the
line which is currently updated, is set to a binary one
(ON) and the procedure then proceeds to a block 267. In
the block 265 the coefficient number (n + m/2) in the
line which is currently updated, is set to a binary zero
(OFF) and the procedure then proceeds to the block 267.

In the block 267 n is incremented by one and the
procedure then proceeds to a block 269. In the block 269
it is checked if n is smaller than the line length
divided by 2, i.e. if n < m/2. If this is the case the
procedure returns to the block 255 and else the procedure
proceeds to a block 271 in which the procedure stops.

The method of calculating the lossless mask for the
region of interest can also be expressed as pseudo code
as is shown below.

```
update_line(line)
{
    for(n=0;n<line_length/2;n++)
    {
        if argument_line[2n-2] OR argument_line[2n-1] OR
        argument_line[2n  ] OR argument_line[2n+1] OR
        argument_line[2n+2] OR argument_line[2n+3]
        {
            /*turn on low*/
            return_line[n]=ON;
        }
        else return_line[n]=OFF;

        if argument_line[2n  ] OR argument_line[2n+1]
        {
            /*turn on high*/
            return_line[n+line_length/2]=ON;
        }
        else return_line[n+line_length/2]=OFF;
    }
}


Make_lossless_mask
{
    Make_ROI_mask();/*obtain a mask of the ROI in the
image plane*/

    /*level loop*/
    horizontal_subband_length=horizontal_image_size;
    vertical_subband_length=vertical_image_size;

    for(all_levels_of_the_transform)
    {
        /*horizontal split*/
        for(line=0;line<vertical_subband_length;line++)
        {
            update_horizontal_line(line);
```

```
        }

        /*vertical split*/

    for(line=0;line<horizontal_subband_length;line++)
        {
                update_vertical_line(line);
        }

        horizontal_subband_length/=2;
        vertical_subband_length/=2;

    }

}
```

In Figs. 3a - 3e, the binary bit masks obtained for
different levels or stages are illustrated. Thus in Fig.
3a the mask of the desired ROI in the image plane is
shown, e.g. the region transmitted from the receiver to
the transmitter in the description above.

In Fig. 3b the binary mask for the coefficients needed at
the second sub band stage is shown.

In the Figs. 3c - 3e the corresponding masks for the
fourth, fifth and seventh sub-band stages are shown,
respectively.

In another preferred embodiment the prediction is
extended to using the low frequency coefficients $L(n-2)$,
$L(n-1)$, $L(n)$, $L(n+1)$, $L(n+2)$. The prediction is therefore:

$$P(n) = a_{n-2} * L(n-2) + a_{n-1} * L(n-1) + a_n * L(n) + a_{n+1} * L(n+1) + a_{n+2} * L(n+2) + a_0$$

For example if the coefficients are:

$$a_{n-2} = -3/64$$
$$a_{n-1} = 22/64$$

$$a_n = 0$$
$$a_{n+1} = -22/64$$
$$a_{n+2} = 3/64$$
$$a_0 = -32/64$$

the filter is identical to the Two-Ten transform used in the CREW as described in RICOH CREW Image Compression Standard Version 0.11 (Draft 11), 24 October 1997, RICOH Silicon Valley, Inc. If the coefficients an-2 and an+2 are equal to 0 the predictor will be the A-predictor. Predictors using more coefficients are also possible.

The mask that is found by a backward trace is now slightly extended. To trace a step backwards on a separate line in this case, where $X_m(n)$ is the mask before the step inversion, $L_m(n)$ and $H_m(n)$ are the masks for the low and high frequency sub band afterwards, the following rules are applied:

For the extended predictor:

For all n in $\left[1..\frac{N}{2}\right]$ do:

$$H_m(n) = 1 \text{ If } \{X_m(2n) = 1\}OR\{X_m(2n+1) = 1\} \text{ , 0 otherwise}$$

$$L_m(n) = 1 \text{ If } \{X_m(2n-4) = 1\}OR\{X_m(2n-3) = 1\}OR$$

$$\{X_m(2n-2) = 1\}OR\{X_m(2n-1) = 1\}OR$$

$$\{X_m(2n) = 1\}OR\{X_m(2n+1) = 1\}OR$$

$$\{X_m(2n+2) = 1\}OR\{X_m(2n+3) = 1\}OR$$

$$\{X_m(2n+4) = 1\}OR\{X_m(2n+5) = 1\} \text{ , 0 otherwise}$$

Simple pseudo code for calculating the extended mask is shown below.

```
update_line(line)
{
        for(n=0;n<line_length/2;n++)
```

```
        {
                if argument_line[2n-4] OR argument_line[2n-3]
OR

                argument_line[2n-2] OR argument_line[2n-1] OR
                argument_line[2n  ] OR argument_line[2n+1] OR
                argument_line[2n+2] OR argument_line[2n+3] OR
                argument_line[2n+4] OR argument_line[2n+5]
                {
                        /*turn on low*/
                        return_line[n]=ON;
                }
                else return_line[n]=OFF;

                if argument_line[2n  ] OR argument_line[2n+1]
                {
                        /*turn on high*/
                        return_line[n+line_length/2]=ON;
                }
                else return_line[n+line_length/2]=OFF;

        }
}


Make_lossless_mask
{
      Make_ROI_mask();/*obtain a mask of the ROI in the
image plane*/

      /*level loop*/
      horizontal_subband_length=horizontal_image_size;
      vertical_subband_length=vertical_image_size;

      for(all_levels_of_the_transform)
      {
            /*horizontal split*/
            for(line=0;line<vertical_subband_length;line++)
            {
                    update_horizontal_line(line);
            }
```

```
            /*vertical split*/

      for(line=0;line<horizontal_subband_length;line++)
            {
                        update_vertical_line(line);
            }

            horizontal_subband_length/=2;
            vertical_subband_length/=2;

      }
}
```

Also, it is possible to change the form, size and
location of the region of interest during transmission
when using the method and device as described herein. The
only steps that need to be performed is transmission of a
request for another region of interest from the receiver
to the transmitter, which then can calculated a new mask
corresponding to the new region of interest and then
transmit the coefficient corresponding to this new mask
to the receiver. The request for another region of
interest can also be generated at another location than
in a receiver, for example by a program in the
transmitter.

Such a function can be very useful in many applications.
It is, for example, not always that the receiver receives
the region of interest that he/she desires. In that case
he/she can transmit a request for a larger region of
interest or even a completely different region of
interest.

Therefore, in a preferred embodiment, the transmitter is
provided with means for receiving a new region of
interest from, for example, a receiver during
transmission of an image, and for calculating a mask
corresponding to such a new region of interest. A new
region of interest can then be transmitted from the
transmitter to the receiver.

Thus, a method and a device for transmission of S+P transform coded digitized images using a mask by means of which a region of interest (ROI) can be transmitted lossless without having to transmit the remaining part of the digitized image has been described. The use of the mask makes it possible to transmit and receive the ROI lossless and still maintaining a good compression ratio for the image as a whole. This is possible since no or very few bits can be used for the remaining part of the image.

Furthermore, a mask calculated according to the principles described herein can be used for transmitting the coefficients required for obtaining a lossless ROI at any time during the transmission.

CLAIMS

1. A method of lossless region of interest transmission of an S+P transform coded digitized image, **characterized in** that a mask is calculated indicating the coefficients of the S+P transformed image, which corresponds to the region of interest, and that these coefficients are transmitted.

2. A method according to claim 1, **characterized in** that the coefficients of the S+P transformed image corresponding to the region of interest are transmitted in the early stages of the transmission in order to obtain a lossless region of interest in a receiver, and a lossy remaining image.

3. A method according to any of claims 1 - 2, **characterized in** that the mask is obtained by tracing a step backwards on a separate line, and that the following steps then are carried out:

- set $\quad H_m(n) = 1$ If $\{X_m(2n) = 1\} OR \{X_m(2n+1) = 1\}$, and 0 otherwise

- set $\quad L_m(n) = 1$ If $\{X_m(2n-2) = 1\} OR \{X_m(2n-1) = 1\} OR$

$\{X_m(2n) = 1\} OR \{X_m(2n+1) = 1\} OR$

$\{X_m(2n+2) = 1\} OR \{X_m(2n+3) = 1\}$, and 0 otherwise

for all n in $\left[1, \frac{N}{2}\right]$, where $X_m(n)$ is the mask before the step inversion, $L_m(n)$ and $H_m(n)$ are the masks for the low and high frequency sub band afterwards, and where n is the number of a coefficient in line, which is updated.

4. A method according to any of claims 1 - 2, **characterized in** that the mask is obtained by tracing a step backwards on a separate line, and that the following steps then are carried out:

- set $\quad H_m(n) = 1$ If $\{X_m(2n) = 1\} OR \{X_m(2n+1) = 1\}$, and 0 otherwise

- set $\quad L_m(n) = 1$ If $\{X_m(2n-4) = 1\} OR \{X_m(2n-3) = 1\} OR$

$\{X_m(2n-2) = 1\} OR \{X_m(2n-1) = 1\} OR$

$$\{X_m(2n)=1\}OR\{X_m(2n+1)=1\}OR$$

$$\{X_m(2n+2)=1\}OR\{X_m(2n+3)=1\}OR$$

$$\{X_m(2n+4)=1\}OR\{X_m(2n+5)=1\} ,$$

and 0 otherwise

for all n in $\left[1,\frac{N}{2}\right]$, where $X_m(n)$ is the mask before the step

inversion, $L_m(n)$ and $H_m(n)$ are the masks for the low and
high frequency sub band afterwards, and where n is the
number of a coefficient in line, which is updated.

5. A method according to any of claims 1 – 4, when a
request for new mask is received, **characterized in** that a
new mask corresponding to the new region of interest is
calculated and that the corresponding coefficients are
transmitted.

6. A device for lossless region of interest transmission
of an S+P transform coded digitized image, **characterized
by**
- means for calculating a mask indicating the
coefficients of the S+P transformed image which
corresponds to the region of interest.

7. A method according to claim 6, **characterized by**
- means for transmitting the coefficients of the S+P
transformed image which corresponds to the region of
interest in the early stages of the transmission in order
to obtain a lossless region of interest in a receiver,
and a lossy remaining image.

8. A device according to any of claims 6 – 7,
characterized by
- means for obtaining the mask by tracing a step
backwards on a separate line, and that the following
steps then are carried out:
- set $H_m(n)=1$ If $\{X_m(2n)=1\}OR\{X_m(2n+1)=1\}$,and 0 otherwise
- set $L_m(n)=1$ If $\{X_m(2n-2)=1\}OR\{X_m(2n-1)=1\}OR$

$\{Xm(2n) = 1\}OR\{Xm(2n+1) = 1\}OR$

$\{Xm(2n+2) = 1\}OR\{Xm(2n+3) = 1\}$, and 0 otherwise

for all n in $\left[1.\frac{N}{2}\right]$, where $Xm(n)$ is the mask before the step

inversion, $Lm(n)$ and $Hm(n)$ are the masks for the low and high frequency sub band afterwards, and where n is the number of a coefficient in line, which is updated.

9. A device according to any of claims 6 - 7,
characterized by
- means for obtaining the mask by tracing a step backwards on a separate line, and that the following steps then are carried out:

- set $\qquad Hm(n) = 1$ If $\{Xm(2n) = 1\}OR\{Xm(2n+1) = 1\}$, and 0 otherwise

- set $\qquad Lm(n) = 1$ If $\{Xm(2n-4) = 1\}OR\{Xm(2n-3) = 1\}OR$

$\{Xm(2n-2) = 1\}OR\{Xm(2n-1) = 1\}OR$

$\{Xm(2n) = 1\}OR\{Xm(2n+1) = 1\}OR$

$\{Xm(2n+2) = 1\}OR\{Xm(2n+3) = 1\}OR$

$\{Xm(2n+4) = 1\}OR\{Xm(2n+5) = 1\}$,

and 0 otherwise

for all n in $\left[1.\frac{N}{2}\right]$, where $Xm(n)$ is the mask before the step

inversion, $Lm(n)$ and $Hm(n)$ are the masks for the low and high frequency sub band afterwards, and where n is the number of a coefficient in line, which is updated.

10. A device according to any of claims 6 - 9,
characterized by
- means for calculating a new mask when a request for a new region of interest is received.
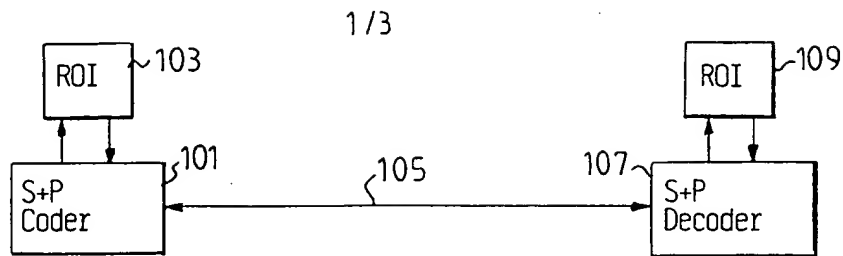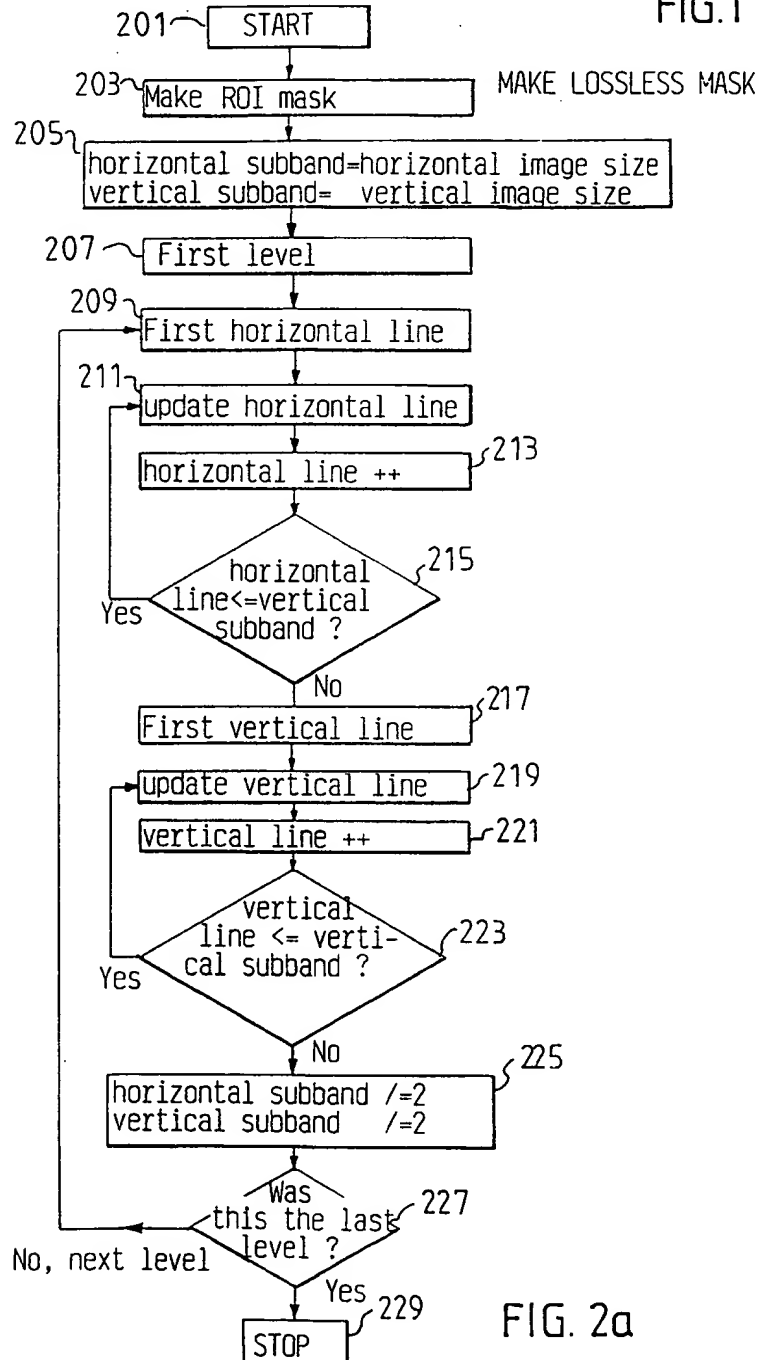
1/3

ROI — 103

ROI — 109

S+P Coder — 101

— 105

107 —

S+P Decoder

FIG.1

201 — START

203 — Make ROI mask   MAKE LOSSLESS MASK

205 — horizontal subband=horizontal image size
vertical subband=   vertical image size

207 — First level

209 — First horizontal line

211 — update horizontal line

horizontal line ++ — 213

horizontal line<=vertical subband ? — 215

Yes

No

First vertical line — 217

update vertical line — 219

vertical line ++ — 221

vertical line <= verti-cal subband ? — 223

Yes

No

horizontal subband /=2
vertical subband /=2 — 225

Was this the last level ? — 227

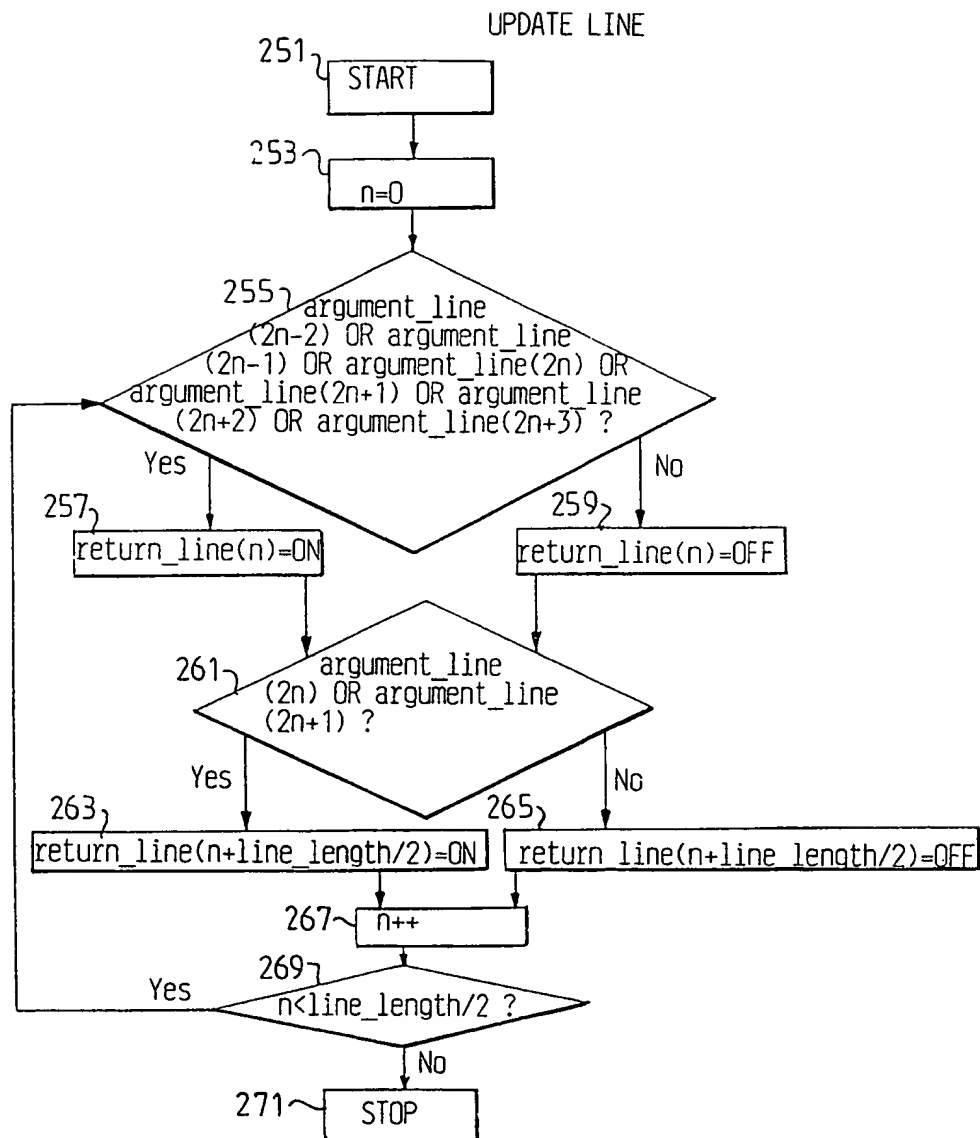No, next level

Yes — 229

STOP — 229

FIG. 2a

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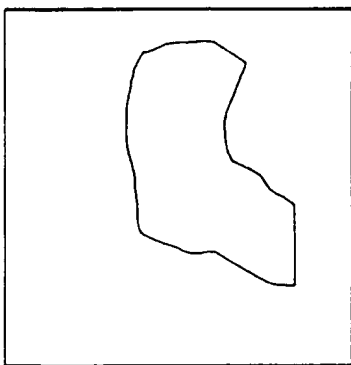
FIG. 2b

Mask of the Desired ROI in the image plane

FIG.3a

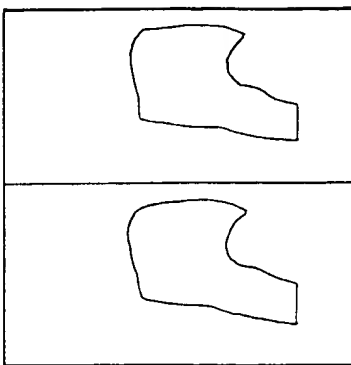Mask of the coefficients needed lossless before the last step of the inverse transform

FIG.3b

Coefficients needed lossless at the four subband stage
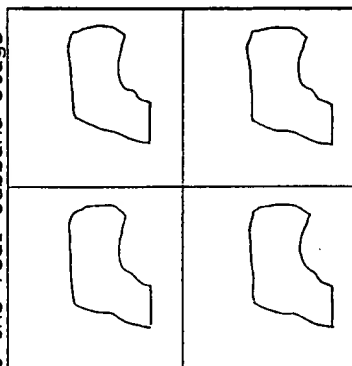
FIG.3c
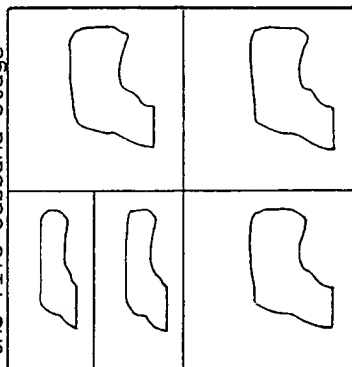

Coefficients needed lossless at the five subband stage

FIG.3d
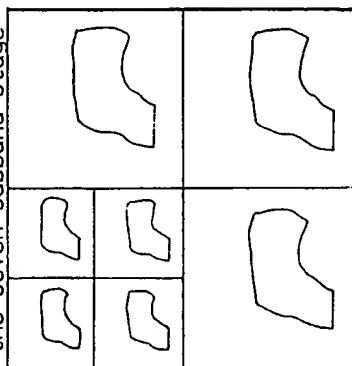

Coefficients needed lossless at the seven subband stage

FIG.3e

1

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G06T 9/00, H04N 7/26 // H04N 7/12
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G06T, H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI,INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Proceedings of the SPIE Conference on Visual Communications and Image Processing,Volume 2094 Part 2, 1993, A Said et al, "Reversible image compression via multiresolution represention and predictive coding", page 664 - 674	1,2,5,6,7,10
A	Signal Processing, Volume 59,No 2,June 1997, J.Ström et al, "Medical image compression with lossless regions of interest", page 155-171	1,2,5,6,7,10

☐ Further documents are listed in the continuation of Box C.   ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance		
"E"	earlier document but published on or after the international filing date	"X"	document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 January 1999	2 9 -01- 1999
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